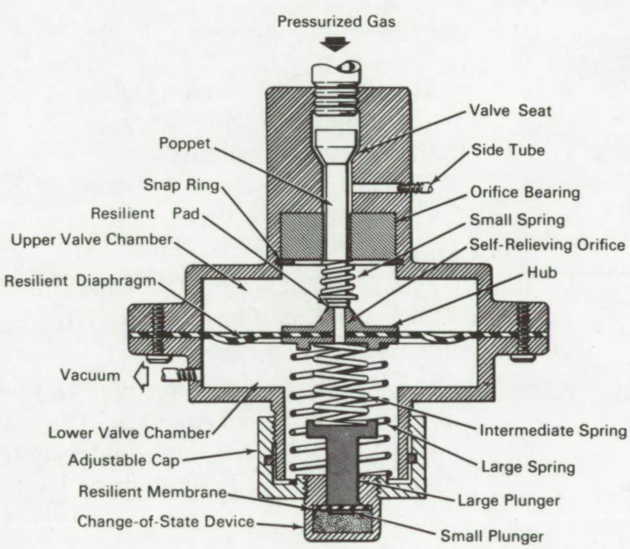
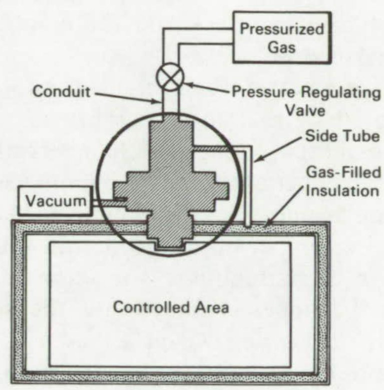
NASA TECH BRIEF

Control System Maintains Compartment at Constant Temperature





The problem:

To maintain an enclosed compartment at a uniform temperature. Prior-art methods involve the use of insulation between the compartment and its external environment. Since static insulation has a relatively constant thermal conductance, the internal temperature to be controlled will vary both with a change in the external temperature and the heat generated in the compartment at an uncontrolled rate.

The solution:

A gas-filled permeable insulating material is interposed between the two walls of a double-walled enclosure surrounding the compartment to be controlled. By regulating the pressure of the gas within the enclosure, the thermal conductivity of the enclosure, and hence the heat transfer between the compartment and the external surroundings can be controlled.

How it's done:

A temperature-sensitive, pressure-regulating system varies the thermal conductance of the gas-filled insulating material by varying the pressure of the gas in the double-walled enclosure.

Threaded into the cap is a temperature-actuated change-of-state device sealed by a resilient membrane. When the material (paraffin, for example) in this device melts, it undergoes a relatively large increase in volume and forces the resilient membrane against a plunger of relatively small cross-sectional area, thus providing a large displacement of the large plunger. An intermediate spring between the large plunger and the rigid hub on the diaphragm provides a restoring

(continued overleaf)

force to the larger plunger upon solidification of the change-of-state material. When the temperature in the compartment rises above the melting point of the change-of-state material, the pressure increase in the gas-filled insulation increases the thermal conductance of the insulation and hence the rate of heat transfer to the external environment. Upon solidification of the change-of-state material, the small plunger retracts under the force of the pressure differential across the resilient diaphragm as transmitted by the intermediate spring. The diaphragm moves toward the lower valve chamber, and the self-relieving orifice in the rigid hub moves away from the resilient sealing pad on the poppet valve stem, allowing gas to flow from the upper valve chamber to the vacuum line. This action in turn removes gas from the insulation through the orifice bearing and the side tube, lowering the pressure until the diaphragm reaches the equilibrium position. This decrease of pressure lowers the thermal conductance of the insulation material, and hence the rate of heat transfer from the compartment to the external environment.

The poppet valve is divided into two chambers separated by a resilient diaphragm, which provides a gas seal between the two chambers of the valve. The upper chamber of the valve communicates with the insulating material in the double-walled enclosure by way of a poppet bore and a side tube. The poppet valve in its normal closed position forms a seal between the upper chamber and the pressurized gas. An orifice bearing which serves as a guide for the valve poppet, includes a path for gas to flow between the upper chamber and the side tube. A conduit connects the poppet valve with the pressurized gas source. A small spring between the snap ring and orifice bearing urges the poppet valve into a closed position. The orifice bearing constricts the passage between the side tube and the upper valve chamber so that pressure buildup can occur in the insulation when the poppet valve is open before the buildup occurs in the upper chamber. The constriction also reduces the rate at which gas is withdrawn from the insulation.

The resilient diaphragm is provided with a rigid hub having a self-relieving orifice which provides a means for gas flow between the upper and lower valve chambers. A pad of resilient material is secured to the end of the poppet stem to provide a gas seal between the upper chamber and the self-relieving orifice. This orifice and the sealing pad serve as a valve between the upper chamber and the lower chamber. In order to operate the system a vacuum source which is connected to the lower chamber of the valve is provided.

Note:

Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California, 91103
Reference: B66-10188

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546.

Source: Jay G. Lindberg
of North American Aviation, Inc.
under contract to
Jet Propulsion Laboratory
(JPL-SC-145)